

Chain-B Software Design Specification

for the

Generation-3 Personnel Safety System (PSS)

of the

Advanced Photon Source

at

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1 Introduction

1.1 Purpose

This Software Design Specification presents the requirements to be use to develop the software for the Personnel Safety System (PSS). This concept is to be use by the programmer to develop the code for the Chain-B PLC that makes up one part of the redundant decision making of the Emergency Shutdown of PSS.

2 Applicable Documents

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein, and the contents of this specification, the contents of this specification shall supersede requirement.

2.1 Government Documents

- DOE ORDER 420.2, November 05,1998
- Accelerator Safety Implementation Guide for DOE O 420.2, Draft, May 1, 1999
- DOE ORDER 5480.25, November 03, 1992
- DOE GUIDANCE 5480.25, September 1, 1993

2.2 Non-Government Documents

- APS Safety Assessment Document(SAD), Rev 1, May 1998, Argonne National Laboratory, Argonne, IL
- Argonne National Laboratory Environment, Safety & Health Manual(ES&H), May 27, 1999
- SLAC Report 327, April 1988, Stanford Linear Accelerator Center, Menlo Park, CA
- NCRP Report No. 88, Issued 30 December 1986, National Council on Radiation Protection

2.3 APS Standard

- E000P-901100...Software Coding Standards for the Personnel Safety System of the Advanced Photon Source

2.4 APS Specifications

- 4104013001-00019-00...Software Coding Standards for the Personnel Safety System Chain "B"
- E000P-901100...Software Coding Standards for the Personnel Safety System of the Advanced Photon Source

2.5 PSS Specifications

- 4104013001-00014-00...Input/Output listings for the beamline Personnel Safety System Chain "B"
- 4104013001-00017-00...System Requirements Specification for the Beamline PSS



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- 4104013001-00016-00...User Software Requirements Specification for the Beamline PSS
- 4104013001-00015-00...Software Requirements Specification (SRS) for the PSS

2.6 Other Publications

- GE Fanuc - Series 90-30 Programmable Coprocessor Module and Support Manual
- Cimplicity- Machine Edition/Logic Developer



2.7 Definitions, acronyms and abbreviations

The following are some of the frequently appearing or unique words or phrases used in this document. These definitions are provided as a quick reference for the reader's convenience.

Down Stream: The direction defined by the path from the Storage Ring to the end of the last Station of a beam line. The beam flow is from the Storage Ring through the Front End Shutters into and through Station A and then to Station B and so on until the beam encounters either a closed Shutter or a beam stop at the end of the last Station.

Up Stream: The direction defined by the path from the end of last Station of a beam line to the Storage Ring. The direction opposite the flow of the beam.

Synchrotron Radiation:

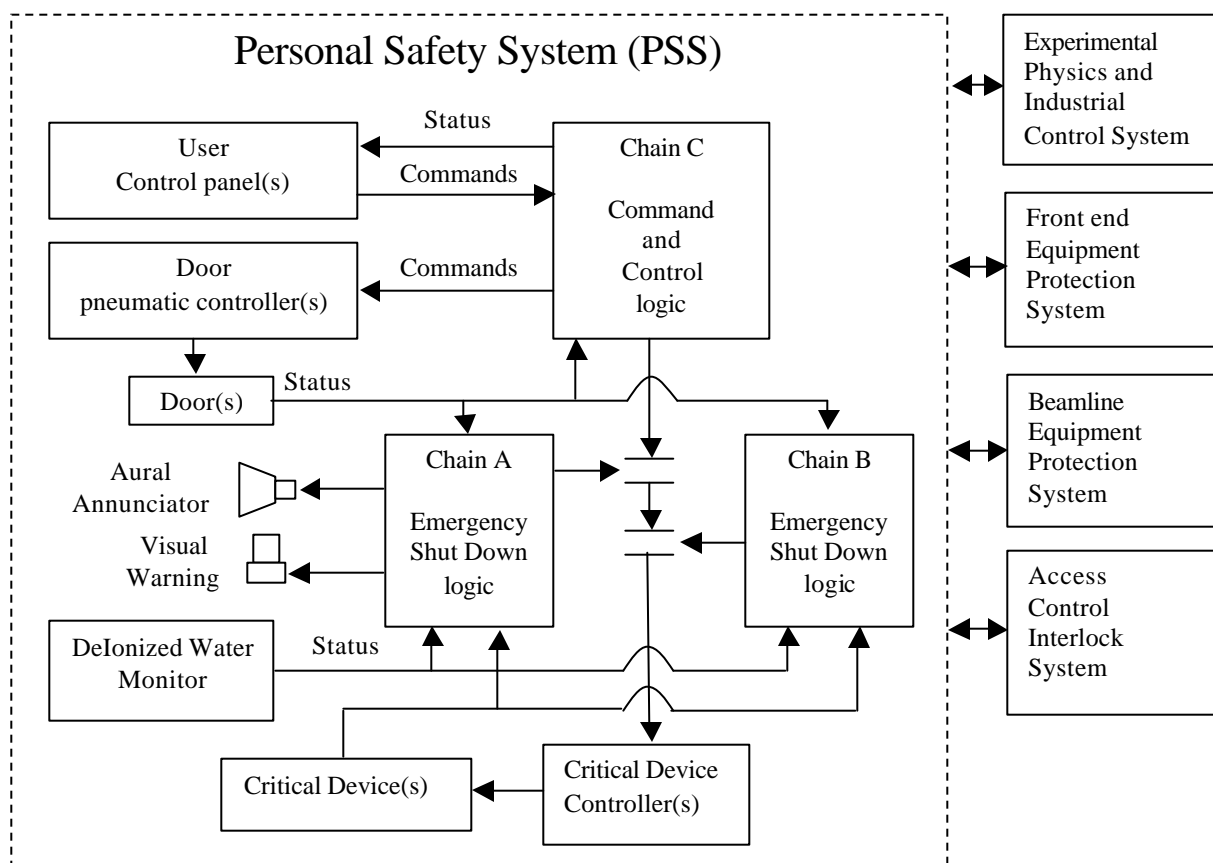
ACIS	Accelerator Control and Interlock System
APS	Advanced Photon Source
ASD	Accelerator Systems Division
BLEPS	Beamline Equipment Protection System
C&C	Command and Control system
CPU	Central Processing Unit
DOE	Department of Energy
ES&H	Environment, Safety & Health Manual
EPICS	Experimental Physics and Industrial Control System
EPS	Equipment Protection System
ESD	Emergency Shut Down system
FEEPS	Front End Equipment Protection System
FOE	First Optics Enclosure
I/O	Input Output
IOC	Input Output Controller
LAN	Local Area Network
NCRP	National Council on Radiation Protection
OI	Operator Interface
PSS	Personnel Safety System
PLC(s)	Programmable Logic Controller(s)
PMD	Programmable Message Display
SAD	Safety Assessment Document
SLAC	Stanford Linear Accelerator Center
SRS	Software Requirements Specification
TBD	To Be Defined/Decided
VME	Versa Module Eurocard
XFD	Experimental Facilities Division



3 Operational Concepts

3.1 Overview

The PSS shall consist of two redundant Emergency Shut Down (ESD) subsystems and a separate command and Control (C&C) subsystem (see system constraints 2.5.1.2 & 2.5.1.3), which in turn interface with systems that control other aspects of the facility. The following block diagram shows the relationships between the major subsystems within PSS and its relationship to the other systems.



Hardware Interface Diagram



3.1.1 Rationale

The PSS system is a system of permits or enables that allow the safe use of an experimental station. Three PLCs from different manufacturers are used to minimize the likelihood that a hardware defect or a programming software package defect would be common to all three and cause simultaneous unsafe operation. The input to the PLCs is through independent sensors and wiring to eliminate the possibility that a single sensor or wire failure will cause improper operation. The output of the PLCs are in series requiring all have to be in an agreement for operation of critical devices. Additionally, three different programmers are used to implement the control code used in the Chain -A, Chain-B and Chain-C PLCs to minimize the chance of propagating a human error from one system to the others.

4 Software Programming Tool

General Electric/GE-Fanuc/Simplicity Machine Edition will be the software tool for programming and configuring the Series 90-30 PLC.

The Chain-B Simplicity Machine Edition will be program in the Ladder Logic structure.



5 Program Design Details

This section contains a narrative for each the Chain-B control device. Together, they comprise the complete function of Chain-B controls.

5.1 Mezzanine Master PLC

This section describes the mezzanine master PLC functions and interfaces.

5.1.1 Match Keying Number

The program code and beamline keying number must equal. The program will not run and PLC will alarm, if the configured software and hardwire key do not equal.

5.1.2 Watch Dog From Chain-A

The program monitors the Chain-A 0>5 Hz pulse. The signal determines whether the Chain-A controller is in a functioning state.

- Beam Active: If pulse not ON, program shall fault and remove permit to critical device.
- Other conditions: If pulse not ON, program shall alarm and will not issue permit to critical device.


5.1.3 Watch Dog To Chain-A

The program generates a 0.5 Hz pulse signal to Chain-A controller.

5.1.4 CPU Key Switch

The key switch enables or disable write protect to the Chain-B CPU.

- Beam Active: If its in write mode, program shall fault and remove permit to critical device.
- Other conditions: If its in write mode, program shall alarm and will not issue permit to critical device.

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5.1.5 PLC Battery

The CPU's backup battery prevents the lost of its memory in the case of power failure.

When the battery is disconnected or its power is below operating range. The program will generate a fault and remove permit to critical devices.

- Beam Active: If below operating range, program shall alarm.
- Other conditions: If below operating range, program shall alarm.

5.1.6 Remote I/O Communication

The master and slave CPUs' communications, via Genius Bus data highway.

- Beam Active: If this communications link is lost, program shall fault and remove permit to critical device.
- Other conditions: If this communications link is lost, program shall alarm and will not issue permit to critical device.

5.1.7 Test Interface Door

Close switch test interface door. This is the test-cart interface portal, for PSS program validation.

- Beam Active: If this input is OFF, program shall fault and remove permit to critical device.
- Other conditions: Program shall alarm and will not issue permit to critical device.

5.1.8 ACIS Global-Online

Permit to access stored beam.

- Beam Active: If this permit is OFF, program shall close FES shutter and remove permit to critical device.
- Other conditions: If this permit is OFF, program will not issue permit to critical device.

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5.1.9 ACIS Shutter Permit

Permit to the Front End Shutter.

- Beam Active: If this permit is OFF, program shall close FES shutter and remove permit to critical device.
- Other conditions: If this permit is OFF, program will not issue permit to critical device.

5.1.10 FEEPS Shutter Permit

Permit to the Front End Shutter.

- Beam Active: If this permit is OFF, program shall close FES shutter and remove permit to critical device.
- Other conditions: If this permit is OFF, program will not issue permit to critical device.

5.1.11 FE Shutter Disable Confirm (<3psi)

FES pressure feedback air valve. Indicator for the FES shutter, that there is <3psi in the air valve.

- Global Online and Beam Active: If this input is ON, program shall close FES shutter, generate a fault and remove permit to critical device.
- Global Online and Not Beam Active: If this input is ON, program shall generate a fault and remove permit to critical device
- Other conditions: If this input is ON, program shall generate fault and will not issue permit to critical device.

5.1.12 FE Shutter Pressure (>60psi)

FES pressure air valve. Indicator for the FES shutter, that there is >60psi in the air valve.

- Beam Active: If this input is OFF, program shall close FES shutter, generate a fault and remove permit to critical device.
- Other conditions: If this input is OFF, program shall fault and will not issue permit to critical device.

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5.1.13 ACIS Trip Test Push Button

Permit to ACIS interface test injection point. When permit is OFF, the ACIS program will remove permit to the stored beam.

5.1.14 Chain-B 24Vdc Field Power Supply Active/OK

This monitors the Chain-B 24Vdc field power supply.

- Beam Active: If this input is OFF, program shall fault and remove permit to critical device.
- Other conditions: If this input is OFF, program shall fault and will not issue permit to critical device.

5.1.15 Mezzanine Test Connector Box Open

This monitors the Test Connector Box interface. When input is OFF, the program is given 2sec. to close FES shutter and remove permit to critical device, before ACIS takes action (Store beam dump).


5.1.16 Any Test Connector Box Open

This monitors the Test Connector Box interface. When input is OFF, the program is given 2sec. to close FES shutter and remove permit to critical device, before ACIS takes action (Store beam dump)..

5.1.17 Photon Stop 1 Opened Limit Switch (PS1_Opened_LS)

The FES shutter PS1Opened limit switch input.

- Station secured and FES not open: If this input is ON, program shall fault and remove permit to critical device.
- Station not secure and FES not open: If this input is ON, program shall remove Storage Ring permit and remove permit to critical device.

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5.1.18 Photon Stop 1 Closed Limit Switch (PS1_Closed_LS)

The FES shutter PS1closed limit switch input.

- Station secured and FES not open: If this input is OFF, program shall fault and remove permit to critical device.
- Station not secure and FES not open: If this input is OFF, program shall remove Storage Ring permit and remove permit to critical device.

5.1.19 Photon Stop 2 Opened Limit Switch (PS2_Opened_LS)

The FES shutter PS2 Opened limit switch input.

- Station secured and FES not open: If this input is ON, program shall fault and remove permit to critical device.
- Station not secure and FES not open: If this input is ON, program shall remove Storage Ring permit and remove permit to critical device.

5.1.20 Photon Stop 2 Closed Limit Switch (PS2_Closed_LS)

The FES shutter PS2 closed limit switch input.

- Station secured and FES not open: If this input is OFF, program shall fault and remove permit to critical device.
- Station not secure and FES not open: If this input is OFF, program shall remove Storage Ring permit and remove permit to critical device.

5.1.21 Safety Stop 1 Opened Limit Switch (SS1_Opened_LS)

The FES shutter SS1Opened limit switch input.

- Station secured and FES not open: If this input is ON, program shall fault and remove permit to critical device.
- Station not secure and FES not open: If this input is ON, program shall remove Storage Ring permit and remove permit to critical device.

5.1.22 Safety Stop 1 Closed Limit Switch (SS1_Closed_LS)

The FES shutter SS1closed limit switch input.

- Station secured and FES not open: If this input is OFF, program shall fault and remove permit to critical device.
- Station not secure and FES not open: If this input is OFF, program shall remove Storage Ring permit and remove permit to critical device.

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5.1.23 Safety Stop 2 Opened Limit Switch (SS2_Opened_LS)

The FES shutter SS2Opened limit switch input.

- Station secured and FES not open: If this input is ON, program shall fault and remove permit to critical device.
- Station not secure and FES not open: If this input is ON, program shall remove Storage Ring permit and remove permit to critical device.

5.1.24 Safety Stop 2 Closed Limit Switch (SS2_Closed_LS)

The FES shutter SS2 closed limit switch input.

- Station secured and FES not open: If this input is OFF, program shall fault and remove permit to critical device.
- Station not secure and FES not open: If this input is OFF, program shall remove Storage Ring permit and remove permit to critical device.

5.1.25 Photon Stop 1 Safe to Open Permit

PS1 open permit. When all conditions are satisfy, this output provides permit for PS1 open.

5.1.26 Photon Stop 2 Safe to Open Permit

PS2 open permit. When all conditions are satisfy, this output provides permit for PS2 open.

5.1.27 Safety Stop 1 Safe to Open Permit

SS1 open permit. When all conditions are satisfy, this output provides permit for SS1 open.

5.1.28 Safety Stop 2 Safe to Open Permit

SS2 open permit. When all conditions are satisfy, this output provides permit for SS2 open.

5.1.29 Photon Stop 1 Closed Limit Switch to ACIS

PS1 closed limit switch status output to ACIS.

5.1.30 Photon Stop 1 Opened Limit Switch to ACIS

PS1 opened limit switch status output to ACIS.

5.1.31 Photon Stop 2 Closed Limit Switch to ACIS

PS2 closed limit switch status output to ACIS.

**5.1.32 Photon Stop 2 Opened Limit Switch to ACIS**

PS2 opened limit switch status output to ACIS.

5.1.33 Safety Stop 1 Closed Limit Switch to ACIS

SS1 closed limit switch status output to ACIS.

5.1.34 Safety Stop 1 Opened Limit Switch to ACIS

SS1 opened limit switch status output to ACIS.

5.1.35 Safety Stop 2 Closed Limit Switch to ACIS

SS2 closed limit switch status output to ACIS.

5.1.36 Safety Stop 2 Opened Limit Switch to ACIS

SS2 opened limit switch status output to ACIS.

5.1.37 Storage Ring Permit

Storage Ring permit to ACIS. If output is OFF, ACIS will abort store beam.

5.1.38 Testing Acknowledged

Confirm test cart to proceed with test mode.

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5.2 Station Slave PLC

This section describes the Experimental floor PLCs functions and interface.

5.2.1 Station User Key Enabled

Enable station search and secure permit.

- Station secured: If this input is OFF, program shall remove permit to critical device.
- Beam Active: If this input is OFF, program will close shutter and remove its permit.

5.2.2 Station APS Key Enabled

Enable shutter permit, allow critical device to open.

- Station secured: If this input is OFF, program shall remove permit to critical device.
- Beam Active: If this input is OFF, program will close shutter and remove its permit.

5.2.3 Major/Serious Reset Key Switch

Kirk lock key for the Major or Serious fault reset. Fault will only reset when conditions are satisfied.

5.2.4 Station-A Test Connector Box Open

Test interface box at Station-A.

- Global ON-line and FES is open: If this input is OFF, program will close FES <2sec. and remove permit to critical device.
- Global Off-line: If this input is OFF, program remove permit to critical device.

5.2.5 Station Door Sensor

Station door mechanical switch input, open input is OFF and close input is ON.

- FES not open: If this input is OFF, no action.
- Station FES open: If this input is OFF, program shall remove Storage Ring permit and remove permit to critical device.



5.2.6 Station Emergency Stop Button

Emergency Stop button input. Normally closed, actuated when OFF.

- Station is Beam Active: If this input is OFF, program shall remove Storage Ring permit and remove permit to critical device.
- Station secured: If this input is OFF, program shall fault and remove permit to critical device.
- Station not secure: If this input is OFF, no action.

5.2.7 Station Search From Chain-A

Station Search input from Chain-A. When this input is ON, the relevant Station is search and secured.

5.2.8 MS1 Opened Limit Switch (MS1_Opened_LS)

The MS1 opened limit switch input, indicator of MS1 cylinder opened.

- While this shutter closed: If this input is ON, program shall fault and remove permit to critical device.
- While this shutter opened: If this input is OFF, program will close shutter and remove permit to critical device.

5.2.9 MS1 Closed Limit Switch (MS1_Closed_LS)


The MS1 closed limit switch input, indicator of MS1 cylinder close.

- While this shutter opened: If this input is ON, program shall fault and remove permit to critical device.
- While this shutter closed: If this input is OFF, program will close shutter and remove permit to critical device.

5.2.10 MS2 Opened Limit Switch (MS2_Opened_LS)

The MS2 opened limit switch input, indicator of MS2 cylinder opened.

- While this shutter closed: If this input is ON, program shall fault and remove permit to critical device.
- While this shutter opened: If this input is OFF, program will close shutter and remove permit to critical device.

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5.2.11 MS2 Closed Limit Switch (MS2_Closed_LS)

The MS2 closed limit switch input, indicator of MS2 cylinder closed.

- While this shutter opened: If this input is ON, program shall fault and remove permit to critical device.
- While this shutter opened: If this input is OFF, program will close shutter and remove permit to critical device.

5.2.12 PS Opened Limit Switch (PS_Opened_LS)

The PS opened limit switch input, indicator of PS cylinder opened.

- While this shutter closed: If this input is ON, program shall fault and remove permit to critical device.
- While this shutter opened: If this input is OFF, program will close shutter and remove permit to critical device.

5.2.13 PS Closed Limit Switch (PS_Closed_LS)

The PSclosed limit switch input, indicator of PS cylinder closed.

- While this shutter opened: If this input is ON, program shall fault and remove permit to critical device.
- While this shutter opened: If this input is OFF, program will close shutter and remove permit to critical device.

5.2.14 SS Opened Limit Switch (SS_Opened_LS)


The SS opened limit switch input, indicator of SS cylinder opened.

- While this shutter closed: If this input is ON, program shall fault and remove permit to critical device.
- While this shutter opened: If this input is OFF, program will close shutter and remove permit to critical device.

5.2.15 SS Closed Limit Switch (SS_Closed_LS)

The SS closed limit switch input, indicator of SS cylinder closed.

- While this shutter opened: If this input is ON, program shall fault and remove permit to critical device.
- While this shutter opened: If this input is OFF, program will close shutter and remove permit to critical device.

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5.2.16 Shutter MS1 Permit

MS1 open permit. When all conditions are satisfy, this output provides permit for MS1 open.

5.2.17 Shutter MS2 Permit

MS2 open permit. When all conditions are satisfy, this output provides permit for MS2 open.

5.2.18 Shutter PS Permit

PS open permit. When all conditions are satisfy, this output provides permit for PS open.

5.2.19 Shutter SS Permit

SS open permit. When all conditions are satisfy, this output provides permit for SS open.

5.2.20 Shutter Pressure OK to Operating Permit

>60psi integral pressure ok switch input. When this input is ON, program will provide permit to its shutter.